MONITORING THE PESTICIDE TREATMENTS OF THE JAPANESE BEETLE ERADICATION PROJECT, SACRAMENTO COUNTY, CALIFORNIA, 1983 - 1986

VOLUME I: CARBARYL

BY

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ENVIRONMENTAL HAZARDS ASSESSMENT PROGRAM

State of California

Memorandum

To : John Sanders, Ag. Program Supervisor
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Date : December 23, 1988

Place : Sacramento

Phone: 3-3654

From : **Department of Food and Agriculture** -Randall Segawa, Sr. Env. Hazards Scientist
Environmental Hazards Assessment Program

Subject: Executive Summary for the Report "Monitoring the Pesticide Treatments of the Japanese Beetle Eradication Project, Sacramento County, California, 1983 - 1986. Volume I: Carbaryl"

In the summer of 1983, the Sacramento County Agriculture Department and the California Department of Food and Agriculture (CDFA) initiated a program to eradicate an infestation of the Japanese Beetle in Orangevale, California. One phase of the eradication program consisted of multiple applications of the pesticide carbaryl to foliage for each of the three summers for 1983, 1984 and 1985.

The Environmental Hazards Assessment Program of the CDFA monitored carbaryl concentrations on foliage and in soil and water through the spring of 1986. Concentrations were very similar to those seen during similar programs to eradicate the gypsy moth, and were low for all media compared to the California Department of Health Services recommended Health Action Level for drinking water of 60 parts per billion. No accumulation of residues from one application to the next was observed, even when applications were four to nine days apart.

The pesticides isofenphos and diazinon were also used during this eradication program. Monitoring results for these pesticides will be reported separately.

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ABSTRACT

The Japanese beetle has the potential of being a serious agricultural pest if it becomes established in California. Therefore, the Sacramento County Agriculture Department and the California Department of Food and Agriculture conducted a program to eradicate an infestation found in the Orangevale area. This program was initiated during the summer of 1983 and continued through the spring of 1986. One phase of the eradication program consisted of multiple applications of carbaryl to foliage during each of the three summers for 1983, 1984, and 1985. The same materials and procedures were used on earlier gypsy moth infestations in the state. The Environmental Hazards Assessment Program monitored carbaryl concentrations in foliage, soil, and water.

Foliage levels during 1983 and 1985 agreed with those found on earlier gypsy moth programs. The 1983 foliage concentrations ranged between 35 and 190 ppm (dry wt), while the 1985 concentrations ranged between 11 and and 722 ppm (dry wt) or 0.11 and 7.19 $\mu g/cm^2$. The 1984 treatment program consisted of more frequent carbaryl applications. Concentrations during 1984 were higher, ranging from 36 to 1820 ppm (dry wt) or 0.82 to 20.1 $\mu g/cm^2$.

Soil residues were monitored only during 1984, when more frequent applications were made. Carbaryl concentrations in soil ranged from 0.3 to 14.1 ppm. These levels were slightly higher than those found on earlier gypsy moth programs.

Surface water was monitored on two occasions, during the 1983 rainfall season and during a special application adjacent to Arcade Creek in 1984. Carbaryl concentrations in creeks during the first large rain storm of 1983 were lower than those found on earlier gypsy moth programs. They ranged from no detectable amount to 13 ppb. The highest measured rate of carbaryl leaving the treatment area through runoff was 32 g/hr during this rain storm. Even if this discharge rate continued for a 25 day period the total amount discharged would be less than 1% of the total 1952 kg of carbaryl applied during 1983. The highest water concentrations during a special application to foliage along Arcade Creek was 4.0 ppb, which was lower than the 14 ppb detected before application.

Carbaryl concentrations resulting from these Japanese beetle treatments were similar to those seen during gypsy moth programs. No accumulation of residues from one application to the next was observed, even when applications were four to nine days apart. Off-target movement of carbaryl was low as measured by the amount discharged in runoff and drifting into an adjacent water body.

PREFACE

This report is the first of three volumes describing the environmental monitoring of the pesticide treatment program to eradicate the Japanese beetle infestation in Sacramento County, California, 1983 - 1986. This program consisted of nine separate treatments (summer 1983, fall 1983, spring 1984, summer 1984, fall 1984, spring 1985, summer 1985, fall 1985, and spring 1986), with multiple applications of pesticides during each treatment. Three different pesticides were used during the program, carbaryl, isofenphos, and diazinon. This report presents the monitoring of the pesticide carbaryl, Volume II describes the isofenphos monitoring and Volume III describes the diazinon monitoring.

Each volume also has two companion documents. The first is a short executive summary which explains the monitoring program in lay terms. The second document is a supplement which contains the raw data summarized in the main report. Both of these documents are available on request.

ACKNOWLEDGMENTS

The monitoring was conducted by the Environmental Hazards Assessment Program of the California Department of Food and Agriculture, under the direction of Ronald Oshima. The author wishes to thank the entire Program staff for their invaluable assistance.

We are indebted to the other individuals and agencies which provided cooperative monitoring and/or chemical analyses including the California Department of Fish and Game, the California Department of Health Services, the State Water Resources Control Board, the Central Valley Regional Water Quality Control Board, and the University of California.

Thanks are also extended to the Japanese Beetle Project personnel, and the Sacramento County Agriculture Department for their assistance.

DISCLAIMER

The mention of commercial products, their source or use in connection with material reported herein is not to be construed as an actual or implied endorsement of such product.

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INTRODUCTION

The Japanese beetle, Popillia japonica Newman, has the potential of being a serious agricultural pest if it becomes established in California. Damage occurs as the result of both larval and adult feeding. The larvae feed on the roots of plants, primarily grasses, while adult beetles can feed on the leaves, fruit, and flowers of over 300 plant species (Dowell, 1983). Areas in California with irrigated turf, and host plants for adults to feed on would be a suitable environment for the Japanese beetle.

Knowledge of the life cycle is crucial to the detection and eradication of Japanese beetle. During the summer the insect is in the adult stage and feeds on above ground portions of host plants. Also at this time, adults lay eggs in the soil. When eggs hatch in late summer the larvae feed on roots of plants, continue to feed through fall and then become inactive in the winter. In the spring the larvae begin to feed again, pupate, and emerge as adults in early summer.

Detection and eradication activities were conducted by the Japanese Beetle Eradication Project, a cooperative effort of the Sacramento County Agriculture Department and the Pest Detection/Emergency Projects Branch of the California Department of Food and Agriculture (CDFA). Detection surveys were conducted in the summer when the adults could be trapped. This was the only time when a population could be detected and the area of the infestation determined. During the summer, the adult population was reduced

by treating the foliage of host plants in the infested area with the pesticide carbaryl. During the fall and spring, soil pesticide applications of isofenphos and/or diazinon were made to turf, pasture, and fallow garden areas to reduce the larval populations. This two-phase treatment program was successful in eradicating the Japanese beetle infestation. This report describes the monitoring for carbaryl; Volumes II and III describe the monitoring for isofenphos and diazinon, respectively.

Carbaryl treatments were monitored by the Environmental Hazards Assessment Program (EHAP) of the CDFA. Extensive monitoring of earlier gypsy moth eradication programs showed concentrations for all media as being too low to have significant environmental or health effects (Neher, 1982; Weaver, 1983). The 1983 and 1985 carbaryl treatments were the same type of programs used on previous gypsy moth projects. Therefore, only limited sampling was conducted for the 1983 and 1985 carbaryl treatments with the objective of determining if the concentration range was the same as found previously. Additional monitoring was conducted in 1984 when more frequent applications were made to a small number of properties within heavily infested areas. Carbaryl concentrations were measured in foliage, soil and water.

TREATMENT PROGRAM

The Japanese beetle infestation was confined to the northern part of Sacramento County, with most of the treatment area located in the town of Orangevale. The size and boundaries of the treatment area changed as new

detection information was evaluated. The outermost boundaries of the carbaryl treatment areas are shown in Figure 1.

Three carbaryl treatments were conducted by the Japanese Beetle Project, summer 1983, summer 1984, and summer 1985. One to nine applications were made to individual properties for each of the three treatments. All foliar treatments used Sevin 80S® as the formulation, which contained 80% carbaryl as the active ingredient. The formulation was a soluble powder mixed with water to a concentration of 0.120% (1 pound carbaryl in 100 gallons of water). Most of the material was applied with truck mounted hydraulic sprayers. The pesticide was sprayed on host plants until the foliage was totally wet. A total of 1952 kg of carbaryl was used in 1983, 1787 kg in 1984, and 1402 kg in 1985.

Carbaryl is an insecticide belonging to the carbamate family, with the following characteristics (Worthing, 1979):

Chemical name: 1-napthalenyl methylcarbamate

Chemical Abstracts number: 63-25-2

Chemical Formula: $C_{12}H_{11}NO_2$

Molecular weight: 201.2

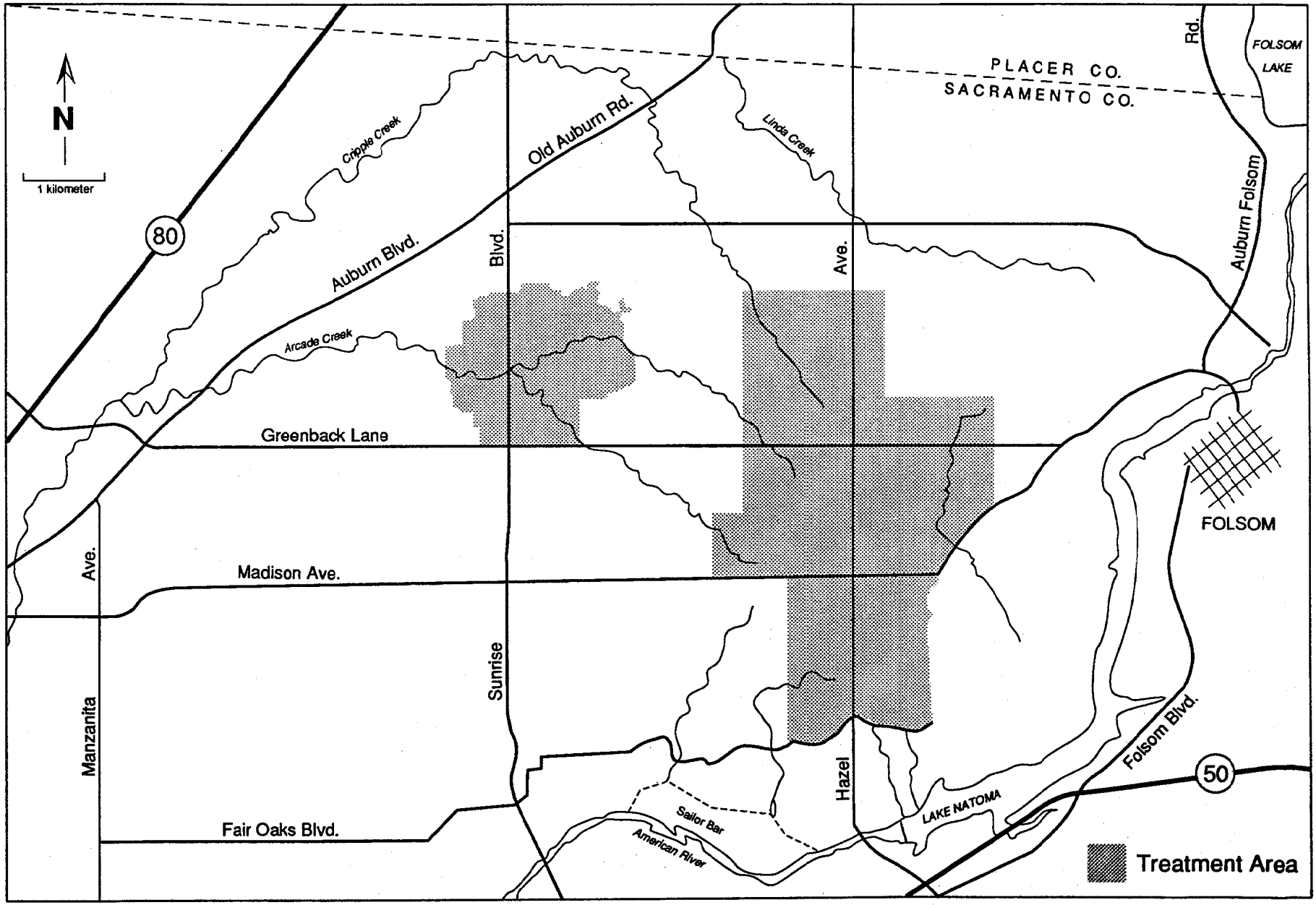
Water solubility: 120 ppm, 30°C

Vapor pressure: $<4 \times 10^{-5}$ torr, 25°C

LD50: 850 mg/kg, rat, oral

Trade name: Sevin®

Figure 1. Carbaryl treatment areas, Japanese Beetle Project, Sacramento, 1983-6.



MATERIALS AND METHODS

Individual residential properties were sampled for foliage and soil, while creeks were sampled for water. Sampled properties were selected based on the amount of foliage and soil which could be sampled, number of applications which would be made, ease of access, and permission of the owner.

Only limited sampling was conducted for the 1983 and 1985 carbaryl treatments. Additional monitoring was conducted in 1984 when more frequent applications were made to a small number of properties.

Foliage Methods

Two replicate leaf samples were collected from each location, on each sampling date. Each sample was a composite of approximately 30 leaves collected at random from at least three trees. Whole leaves were clipped directly into glass jars and sealed with aluminum foil lined lids. The jars were kept cold with ice or refrigeration until they were analyzed by the laboratory.

All samples were analyzed for dislodgable carbaryl residue by the CDFA laboratory. The entire sample was rinsed with a Sur-ten® surfactant solution, and the Sur-ten® was extracted with acetonitrile. The extract was analyzed with a high pressure liquid chromatograph (HPLC) containing a

reverse phase column and UV detector. The leftover leaves were dried and pressed. The leaf area and weight were then determined for each sample.

Laboratory results were reported as total micrograms of dislodgable carbaryl per sample. By dividing the amount of carbaryl (micrograms) by the leaf area (square centimeters) or the leaf weight (grams) the results were expressed in two ways (ug/cm^2 and ppm).

Soil Methods

Soil samples were collected at the same times and beneath the same trees that were sampled for foliage. Two replicate soil samples were collected from each location, on each sampling date. The samples were collected with a steel tube, and consisted of approximately 30 plugs 2.5 cm in diameter and 2.5 cm deep. The plugs were collected at random, placed in glass jars, then cooled until they were analyzed by the laboratory.

The samples were analyzed for carbaryl by the CDFA laboratory. A 10 gram aliquot was extracted with acetonitrile and analyzed with the same HPLC methods as the foliage. The results were reported on a ppm, dry weight basis.

Water Methods

Creek water samples were collected by dipping one liter amber glass bottles. Water flow was also estimated at each of the creek sampling points. The samples were cooled until they were analyzed by the laboratory.

The samples were analyzed for carbaryl by the CDFA laboratory. A 200 ml aliquot was passed through a Baker® C18 column, and the column eluted with methanol. The methanol extract was analyzed with the same HPLC method as the foliage. Results were reported on a parts per billion (ppb) basis.

The amount of carbaryl leaving the treatment area over time, or mass discharge rate (µg/sec), was estimated by multiplying the concentration (ppb or µg/l) and the water flow rate (l/sec). By adding the discharge rates for all sampling points and making a simple conversion, a total mass discharge rate (g/hr) was calculated.

RESULTS AND DISCUSSION

Foliage Results and Discussion

A survey of foliage residue was conducted during the summer 1983 treatment. The results of this survey are shown in Table 1. The concentrations found agree with those found previously by Neher (1982) and Weaver (1983). No accumulation of residue over several applications was observed.

During the peak beetle flight season of the summer of 1984, a number of properties were sprayed every 4 to 9 days rather than the normal interval of 14+ days. To determine if this resulted in elevated concentrations three properties (Locations 40, 41, 42) were sampled every three days. The residues found at two of the properties (Locations 41 and 42) were approximately twice the normal concentration, ranging from 36 to 1820 ppm

Table 1. Results of the carbaryl foliage survey, summer 1983, Japanese Beetle Project, Sacramento, 1983-6. The concentrations are dislodgable carbaryl expressed in parts per million on a dry weight basis.

Location	Number of Applications	Days After Application	N	Carbaryl (ppm) Mean	Standard Deviation	Standard Error
20	1	16	3	190	108	62
04	1	16	3	35	19	11
08	2	9	3	184	57	33
07	2	9	3	70	21	12
01	3	13	3	112	42	24
21	3	12	3	62	60	35

(dry wt) or 0.82 to 20.1 $\mu g/cm^2$ (Figures 2 and 3). However, only two replicates were collected so the increased levels may not be statistically significant. In addition, no accumulation between successive applications was observed.

Two properties were monitored for the first three applications of the summer 1985 treatment. Each property was sampled three times a week. The results of this monitoring is shown in Figures 4 and 5. As expected, low, variable concentrations were found throughout the monitoring period, ranging from 11 to 721 ppm (dry wt) or 0.11 to 7.19 $\mu g/cm^2$. While one property did show slightly elevated concentrations after the third application, the other property showed lower concentrations after the third application.

Figure 2. Dislodgable carbaryl foliage residue ($\mu g/cm^2$), summer 1984, Japanese Beetle Project, Sacramento, 1983-6.

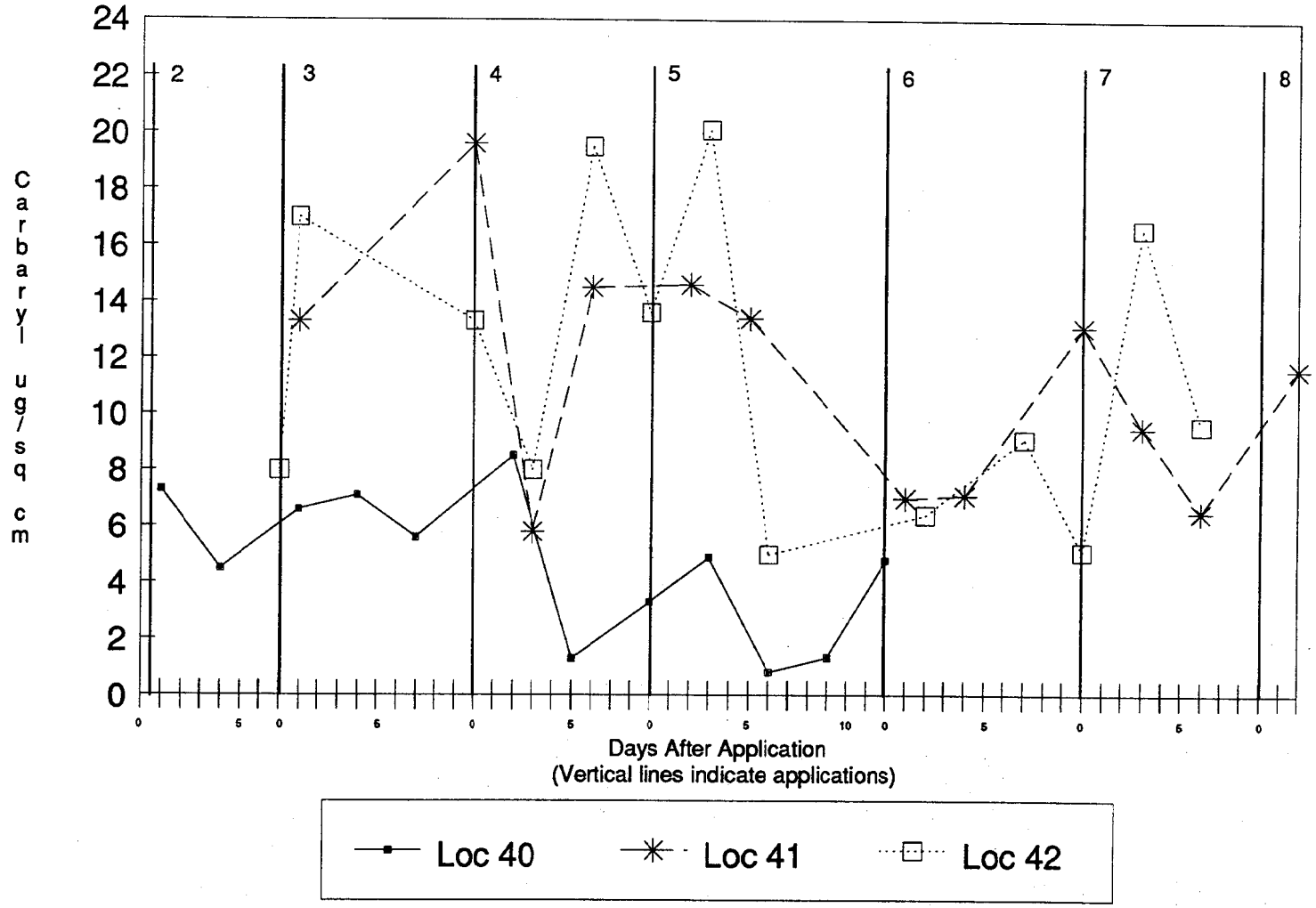


Figure 3. Dislodgable carbaryl foliage residue (ppm), summer 1984, Japanese Beetle Project, Sacramento, 1983-6.

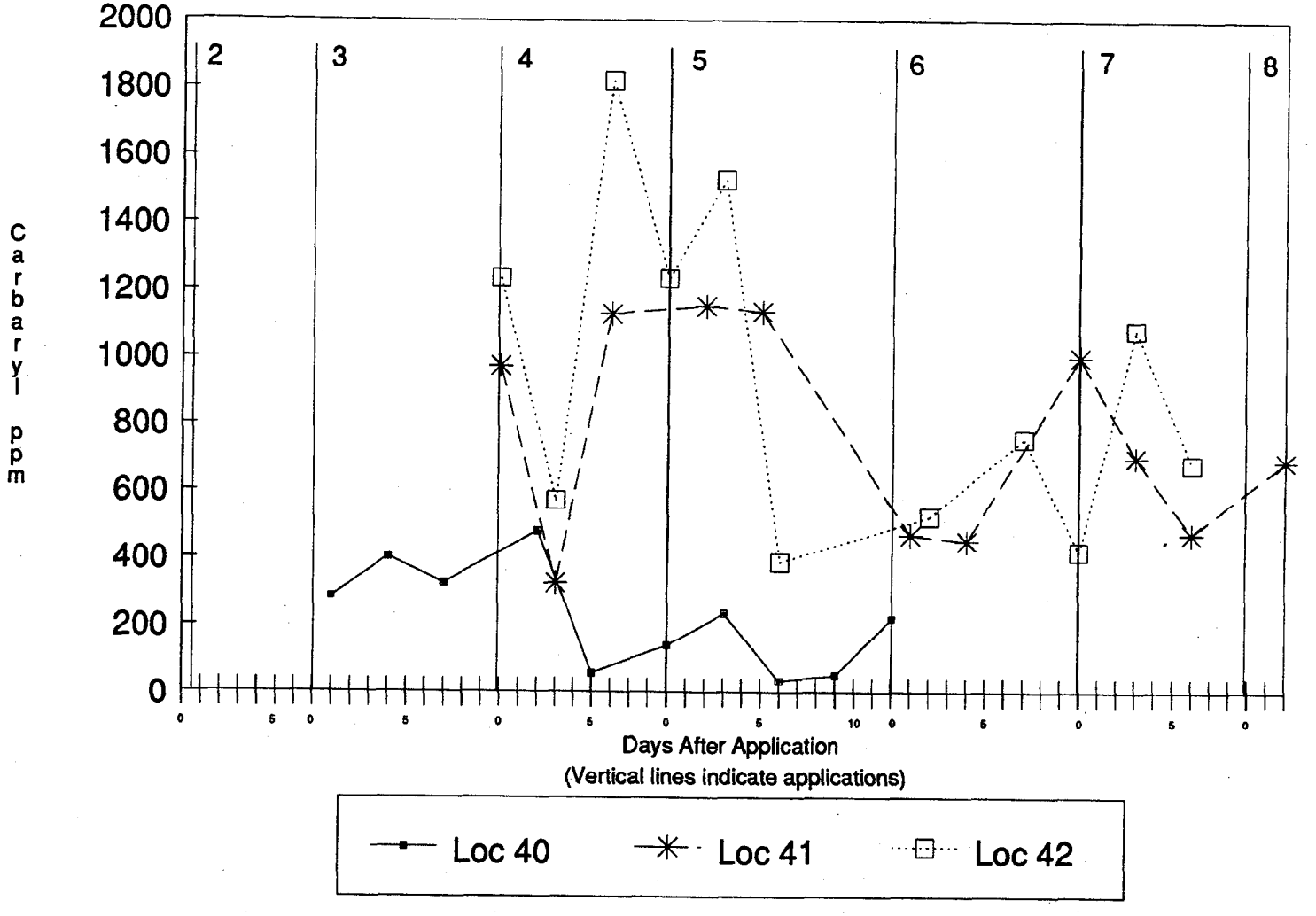


Figure 4. Dislodgable carbaryl foliage residue ($\mu g/cm^2$), summer 1985, Japanese Beetle Project, Sacramento, 1983-6.

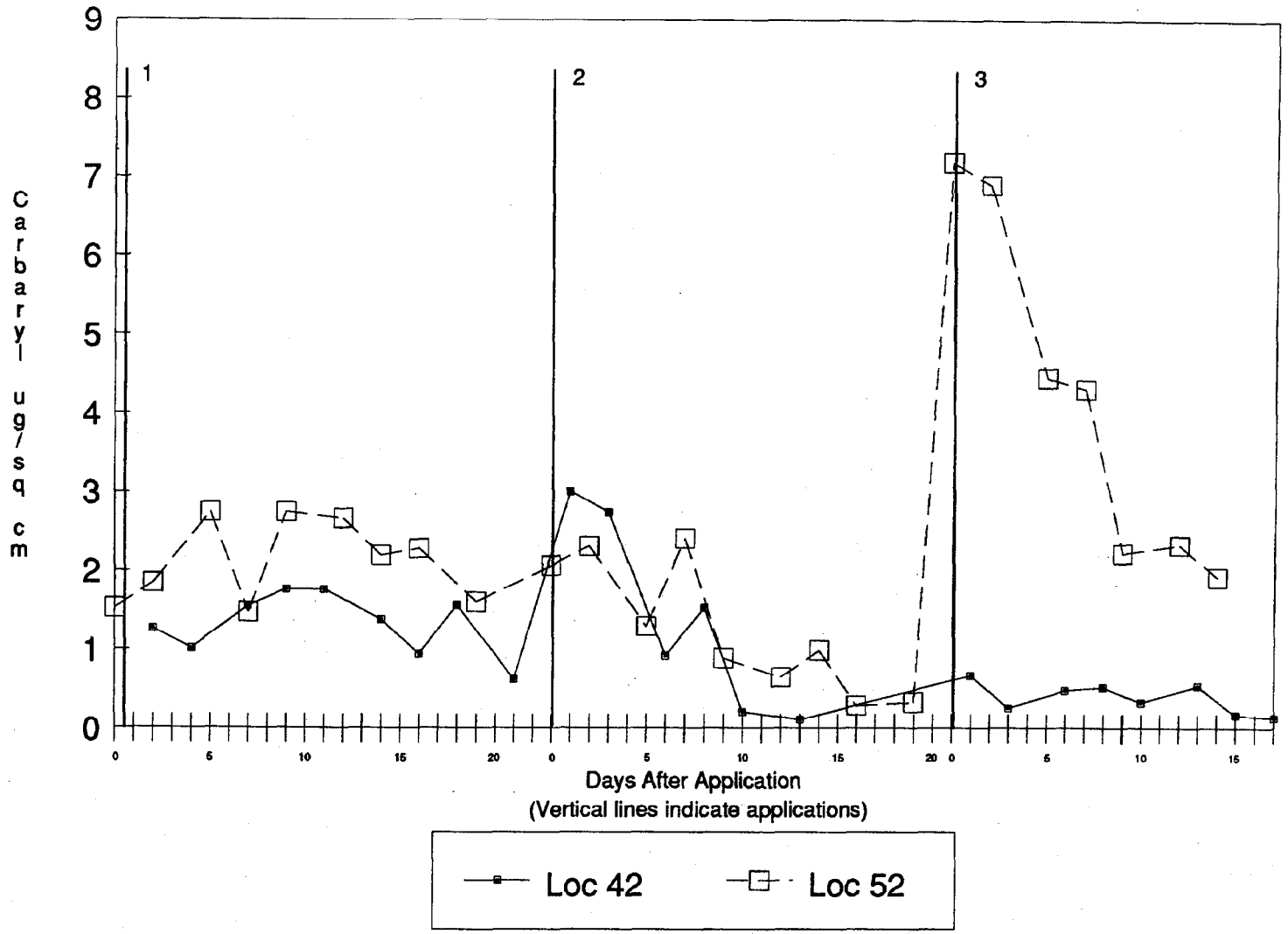
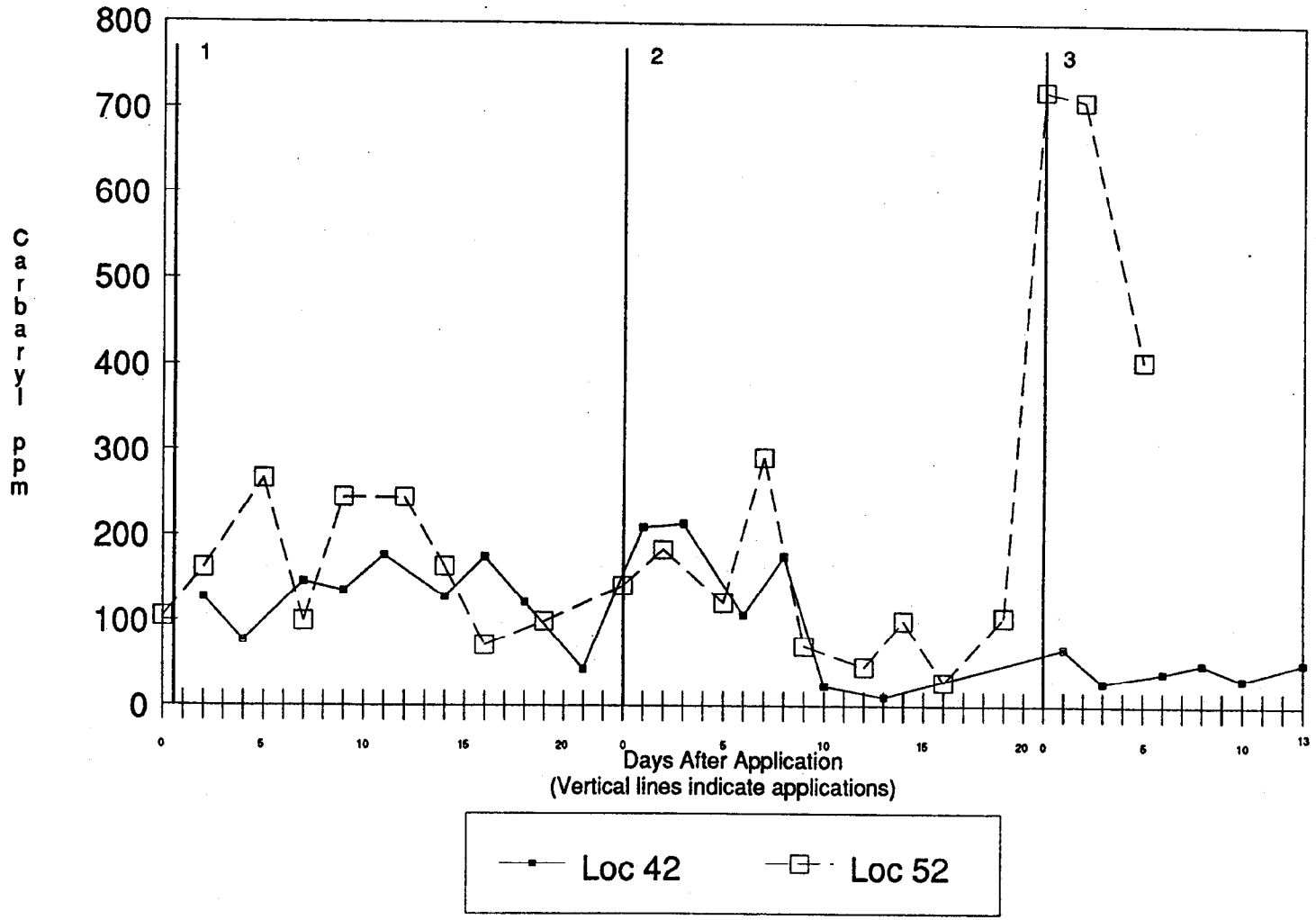


Figure 5. Dislodgable carbaryl foliage residue (ppm), summer 1985, Japanese Beetle Project, Sacramento, 1983-6.



Soil Results and Discussion

Soil monitoring was conducted during the summer 1984 treatment only. Soil was sampled at two of the same locations and times as the foliage samples. The results are shown in Figure 6. Again, concentrations were highly variable, with maximum levels (14.1 ppm, dry wt) slightly higher than those found previously (Neher, 1982). The maximum levels were found the day monitoring was initiated, and all subsequent samples showed a general decreasing trend. No accumulation between applications was observed.

Water Results and Discussion

Surface water samples were collected from creeks during the first major rain runoff period of the 1983 season. The data indicate that concentrations of carbaryl contained in rain runoff were lower than those seen previously (Table 2). This was expected since samples were collected approximately nine weeks after the last application. Previous monitoring programs showed higher concentrations because treatment on gypsy moth programs occurred during the spring rainfall seasons (Neher, 1982; Weaver, 1983). All concentrations were also lower than the California Department of Health Services action level of 60 ppb.

The mass discharge rate, or the amount of carbaryl leaving the treatment area over time was low both times it was measured. Since most of the creeks in this area were actually storm drains, the flow rates were low compared to creeks that have natural flow all year. The low flow rates in the creeks and the low concentrations combined to make the mass discharge rates low.

Figure 6. Carbaryl soil residue, summer 1984, Japanese Beetle Project, Sacramento, 1983-6.

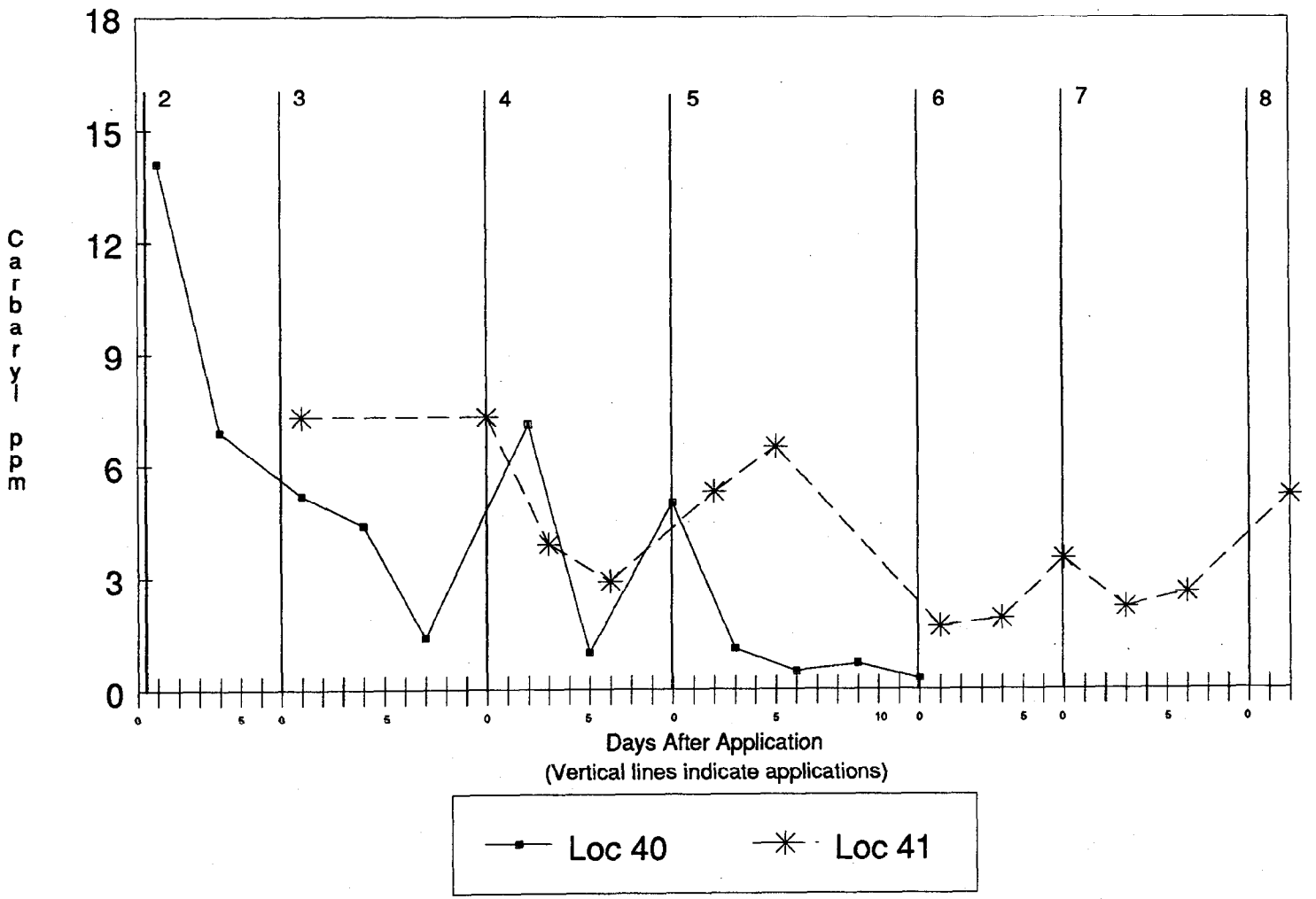
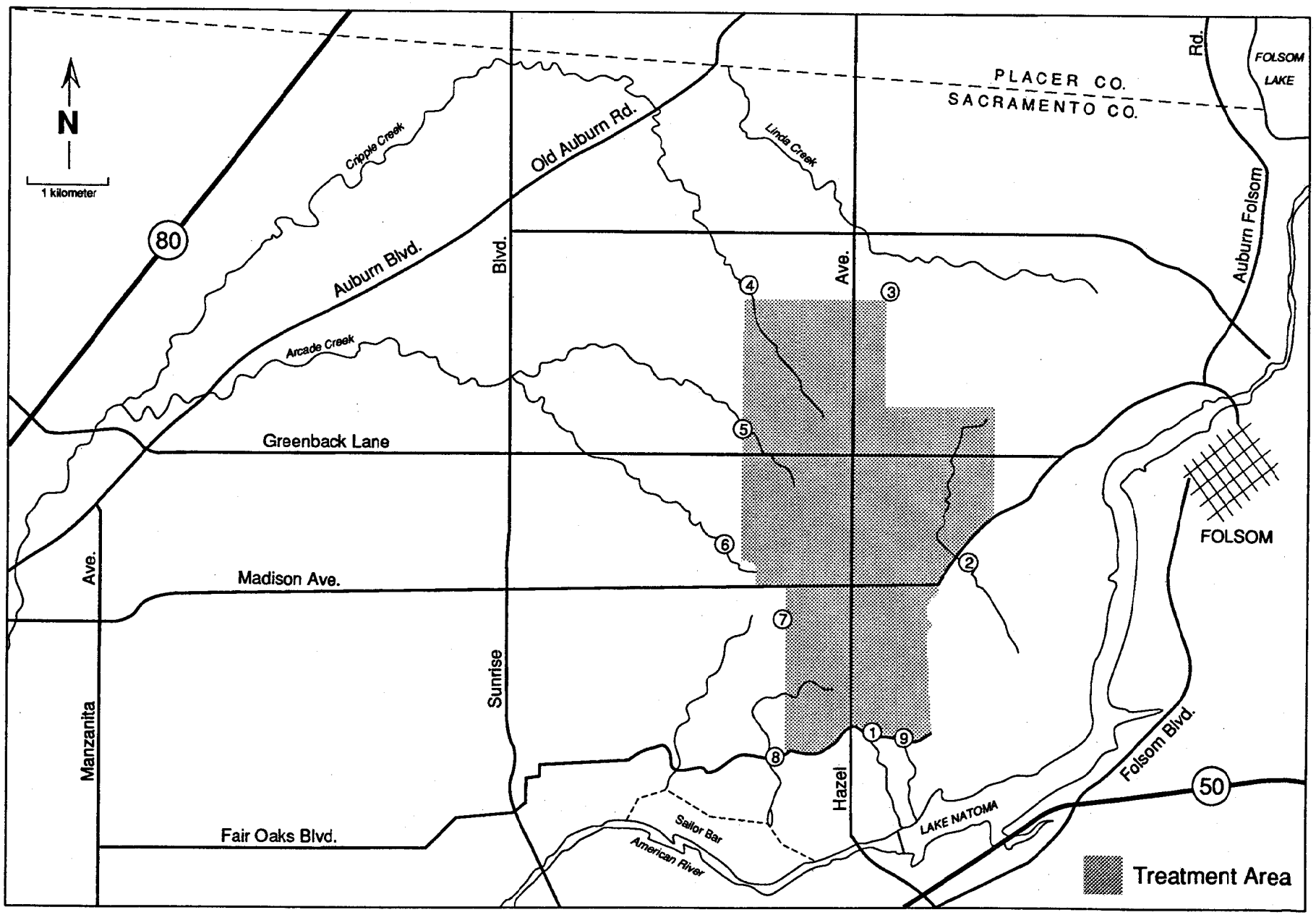


Table 2. Results of the carbaryl rain runoff monitoring, 1983, Japanese Beetle Project, Sacramento, 1983-6. Sampling locations are shown in Figure 7.

		Carbaryl Concentration, ppb (Carbaryl Discharge, µg/sec)	
Site	Date: Rainfall:	11/9/83 0.71 cm	11/10/83 4.2 cm
1		13.0 (250)	5.0 (190)
2		4.0 (800)	<5.0 (0)[a]
3		<1.0 (0)	6.0 (0)
4		<1.0 (0)	5.3 (1100)
5		3.0 (42)	<5.0 (0)
6		4.0 (400)	7.5 (7400)
7		4.0 (12)	5.8 (240)
8		<1.0 (0)	<5.0 (0)
9		2.0 (1)	<5.0 (7)

a "<" indicates no detectable concentration and the detection limit

Figure 7. Carbaryl water sampling sites for rain runoff, 1983, Japanese Beetle Project, Sacramento, 1983-6.



The discharge rates measured during the first rain storm were 5.4 grams of carbaryl per hour on November 9th and 32 g/hr on November 10th. Even if the 32 g/hr rate continued for 25 days the amount discharged would be less than 1% of the total 1952 kg applied in 1983.

During the summer of 1984 a new area was treated. This area contained a section of Arcade Creek which had dense foliage along the banks. After discussions with the Department of Fish and Game, it was deemed necessary to monitor carbaryl water concentrations in Arcade Creek when the foliage along the creek was sprayed to assess the amount of drift. Three monitoring sites were established, immediately upstream of the treatment area, immediately downstream of the treatment area, and near the Natomas East Main Drain, where Arcade Creek empties into the Sacramento River (approximately 25 km downstream). Background samples were collected on June 26, 1984, and monitoring occurred for five hours on June 28 and 11 hours on June 29.

The results showed that all concentrations were very low, and that background levels in the creek (maximum 14 ppb) were higher than concentrations detected during treatment (Table 3). The background concentrations were probably due to runoff from the Japanese Beetle Project and other carbaryl applications upstream and these sources probably contributed more carbaryl to the creek than application drift. This is not surprising considering that approximately 800 hectares (2000 acres) drains into that part of Arcade Creek.

Table 3. Results of the carbaryl water monitoring in Arcade Creek, 1984, Japanese Beetle Project, Sacramento, 1983-6.

	Carbaryl, ppb		
Date/Time	Upstream	Downstream	Near Natomas Drain
6/26/84 (Background)			
1700	5.0	14	3.0
6/28/84 (Spray)			
0800	2.0		
0900		4.0	
1000		4.0	
1100		3.0	
1200		1.5	
1300		4.0	
6/29/84 (Spray)			
0900		0.5	
1000		1.5	
1100		2.0	
1200		3.5	
1300		1.5	
1400		2.0	
1500		2.0	
1600		2.0	
1700		3.0	
1800		2.0	
1900		1.5	
7/1/84			
0755			0.3
2045			0.2
7/2/84			
0805			0.5
1640			0.5

CONCLUSIONS AND RECOMMENDATIONS

The monitoring data showed that carbaryl concentrations resulting from Japanese beetle programs are very similar to those from gypsy moth programs. Carbaryl concentrations in all media were low, but highly variable. Even though Japanese beetle applications occurred more frequently, this apparently did not lead to an accumulation of residues over time. Concentrations in water due to runoff and drift were very low, indicating that off-target movement was minimal. Unless application methods are changed, or application occurs in sensitive or unusual areas, no monitoring would be necessary for future programs.

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